Taylor. S. (2016) The Sprout. *Exploring a culture of Co-operation and Co-construction in Year 9 Science.* New Zealand Science Teacher. Edition 135

THE SPROUT

Exploring a Culture of Co-operation and Co-construction in Year 9 Science

New opportunities for science teachers and students working in flexible learning spaces, writes Simon Taylor of the University of Waikato.

Introduction

This article explores the opportunities in Year 9 science classes where teaching strategies of student co-operation and co-construction were considered. The term co-operation describes students sharing a task together, students having the opportunity to work and interact with their teacher and their peers. Co-operation depends on students to know when it is appropriate to listen and when to speak; to show respect for cultural differences and to be open-minded to different ideas. By contrast the essence of the term co-construction is to create knowledge with others- a kind of knowledge building. Both co-operation and co-construction require a group of learners to take responsibility to create something together. With these approaches in mind, the New Zealand Ministry of Education is encouraging schools to update to more flexible learning spaces (FLS) and activate teaching strategies that augment such environments. This yearlong exploration was with five secondary science teachers at different schools in the central North Island region who have initiated science programmes where students have increased opportunity to be co-operative and co-constructive. The science faculties in this study have had changes to their physical settings creating large open rooms where 60 or more students can work, adjoining rooms with practical science workbenches and smaller break out rooms. While the teachers' experiences are contextual and unique to their own specific situation and community, the study provides a representation of teaching practices that other science teachers might contemplate. Data to inform the case study came from audiotaped teacher workshops, teacher interviews, a student questionnaire and classroom observations. It is titled "The Sprout" to symbolise a rising opportunity to further understand the complexities of adopting this trend.

A current flexible learning space

The study sought to identify successful classroom strategies that were making a positive difference to student engagement, to support the teachers to help frame a co-constructive model used in science lessons and synchronously seek teacher voice to inform the collaborative liaison.

A difficulty facing teachers incorporating cooperative and co-constructive pedagogy in science lessons resides in navigating through a barrage of different teaching strategies, the challenge of time constraints, negotiating student tasks with appropriate physical spaces, ensuring that their students are engaged in authentic science investigation. Alterator and Deed (2013) claim that teachers and students who venture into using multiple physical spaces from traditional one cell-classroom environments find there are demands placed on them to meet expectations of adaptability.

Why pursue this?

The Ministry of Education (MOE) 2016 website sports an optimistic page where innovative learning environments (ILE) are advocated, where schools are required to upgrade their buildings in a five year agreement funding plan which integrates flexible physical classroom spaces (Ministry of Education, 2016). The overall initiative appears to promote not just for changes in physical space but enhancement of pedagogical practices committed to educational outcomes for students. An

assessment tool provided on the website that can assess learning spaces against ILE criteria and there is a statement claiming there has been overwhelming support for a learning studio pilot programme from parents, teachers and boards of trustees. However, on closer investigation there are striking suppositions about the motivation for the changes to the learning environments and perhaps more importantly, the consequential teacher/student pedagogical challenges posed in the new physical spaces remain elusive.

In addition to these new challenges, previous research measuring student perceptions of what happens in science lessons revealed that Year 9 and 10 students were ardent to share greater control with their science teacher (Taylor, 2014). Students preferred a far greater collaborative and participatory science lesson than their actual experiences. Furthermore, historical research of the effects of socio-negotiation have shown positive achievement outcomes in New Zealand science classrooms (Lowe, 2004) and an effect size (d=0.59) in 774 studies worldwide measuring co-operative versus individualistic efforts (Hattie, 2005). These earlier findings invite an opportunity to deepen our understanding of co-operative learning environments. In contrast to these merits, particular difficulty is encountered when attempting to assess the impact of changing physical spaces on student performance. Hattie (2009) reports an analysis of meta-studies indicated little or no impact from open plan environments. As was argued in many of the studies, too often the physical room design had opened the learning space but there was no assurance of deliberate changes in teacher practice.

Opening up the science classroom

Roseth, Fang, Johnson and Johnson (2006) claim
"If you want to increase student achievement, give each student a friend".
As I worked with the teachers this quote above really challenged us. It just seemed too simple and it raised lots of questions about the scope of pedagogy we wanted to see happen in the new learning spaces. We were aware that the level of sharing pedagogical control between teacher and student in science lessons has been historically low in traditional settings with single-cell classrooms. With the new flexible learning spaces the teachers were committed to change but a lot of sharing of ideas needed to take place to identify successful arrangements of group size and student positioning. We wanted to pursue opportunities to explore student/teacher, student/student power sharing and wondered how best to form and manage groups of students in these settings. We also found we needed to work quite carefully in the selection of topics, the design of each topic and to explore how the choice of topic would excite engagement. We were challenged on how to tackle the dilemma of providing activities, which promoted group autonomy but at the same time retaining teacher guidance.

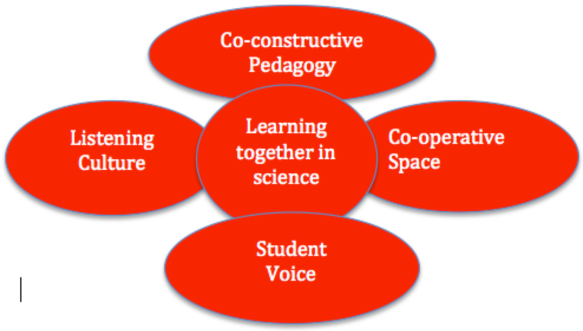
From the initial meetings with the teachers, it was recognised that the interpersonal relations between teacher-student and student-student were paramount in the flexible learning spaces. The main aspects that the teachers noticed to the opening up of the classroom environment were the: adaptability of the physical spaces; interpersonal knowledge; visibility and condition of student learning progress checks. The teacher discussions centred on increased student autonomy, greater student movement in the room/s and more emphasis on collaboration. A model of co-constructive pedagogy illustrated in Figure 1 was designed with the teachers to support the thinking, with discussion on integrated concepts of listening culture, student voice, co-operative space.

Torch making with foil, plastic and batteries.

Co-construction, Co-operation, FLS -What's the link?

In early March a workshop was held, where the teachers and I worked to find out what determined a co-constructive climate. This exercise was challenging, juggling theory with classroom reality fuelled our dialogue. However, the discussions proved invaluable in that we could see a way forward, we assimilated ideas and importantly, we established the links between Co-construction, Co-operation and the flexible learning environment. Teachers saw that it was easy to get lost in the busyness of

the day-to-day organisation of science lessons, and not take into account the importance of the theoretical underpinnings of the changing practice. We arrived at an agreed framework, as illustrated below.
Figure 1.



Examination of the framework shows the interaction of four overlapping concepts around the central focus of *learning together in science*. The teachers interpreted the features of co-*constructive pedagogy* as including: students help each other learn through dialogue; learning goals emerge and develop during the science inquiry; students display communal responsibility including the control of the classroom; students operate together accessing products outside the class community and they evaluate how best they learn. It was evident to these teachers that their students had a range of cognitive process needs, across the various skills in a collaborative investigation. These requirements for example, were for students to use understanding of cause and effect to plan a sequence of actions or to reconstruct conceptual understanding of a problem in search of new solutions. The meaning of co-construction that we negotiated could perhaps be interpreted as knowledge building, a term currently used by Hesse, Care, Buder, Sassenburg and Griffin (2015), where learner centred cognitive understanding builds through collaborative problem solving action.
Creating a *listening culture* was another aspect that came out of the teacher conversations, a concept linked with *student voice* and the ability for students to feel that they are valued members of the science lesson. The flexible learning spaces provided increased opportunity for students to work in different physical spaces, but this did not guarantee a listening culture in the science lesson. Fostering a listening culture posed a challenge to ensure lesson design had opportunity for students to feedback their ideas and that they were given authority and agency as active learners. It could involve assigning roles to students in their investigations or that they design and adopt these roles themselves.
The concept *Co-operative space* encompassed the physical and collaborative interactions between students, and students use of specific social skills in maintaining an inquiry. Drawing on specific skills of conflict resolution, participatory awareness and perspective taking, required careful teaching instruction. The teachers believed that these skills could be taught, and this became an emerging teaching role in the flexible learning spaces. Teachers could not avoid or assume these types of collaborative skills. It was critical that they explained them to all their students.

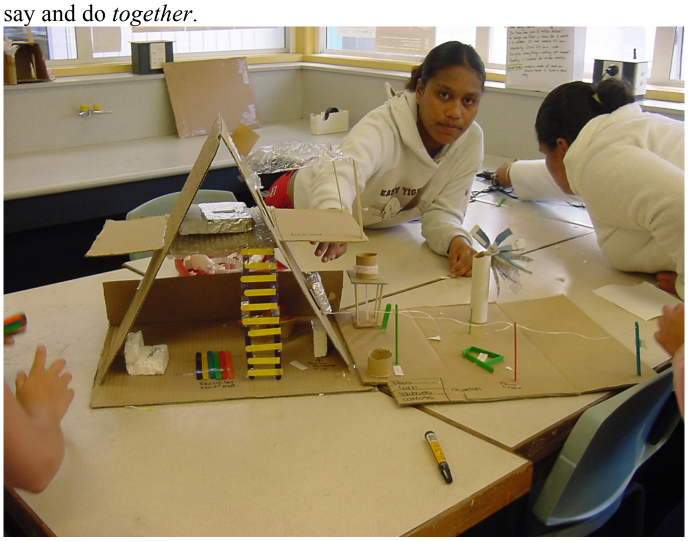
Initial observations

My initial classroom observations indicated positive levels of student engagement, students being on-task and following instructions and that they enjoyed science. I returned to the classrooms over the year to seek further details, listening to the teachers and students. Analysis from an early student questionnaire showed 37% of the students across the five classes said science was their favourite subject, a figure considered high, compared to other class averages. A factor identified about their enjoyment in science was that they appreciated working on projects together in groups. Students said they had more time to talk about ideas and with that, had a better chance to take on different views. The students felt they had opportunities posed to them that were real- they linked with real contexts in everyday life, and that working as a team to present their findings was seen as a rewarding experience.

Co-operation and the scientific café

I was struck by the thought that the classes created a classroom climate as if it was a scientific café and I began to use this term to describe the scenes I observed. Teachers still generally decided topics but the topics had choices of tasks within the inquiry for students to select. Topic examples used were: climate change, human body systems, energy sustainability, a local ecosystem and chemical reactions. Activities in the lessons were recorded as: guessing-judging-predicting, planning, categorising, problem solving, manipulating, making a model and debating. Groups were made up of two to five students sharing materials, books, laptops and equipment.

The flexible learning spaces in the science lessons gave opportunity for students to move to areas and separate rooms where there was increased chance to talk and discuss, so potentially social. Nuthall (2007) has described peer learning as powerful whether co-operatively or competitively. He has claimed that much of the feedback that students receive comes from their peers. Classmates are a significant part of the student-learning world and their experience in lessons is shaped by what they say and do *together*.

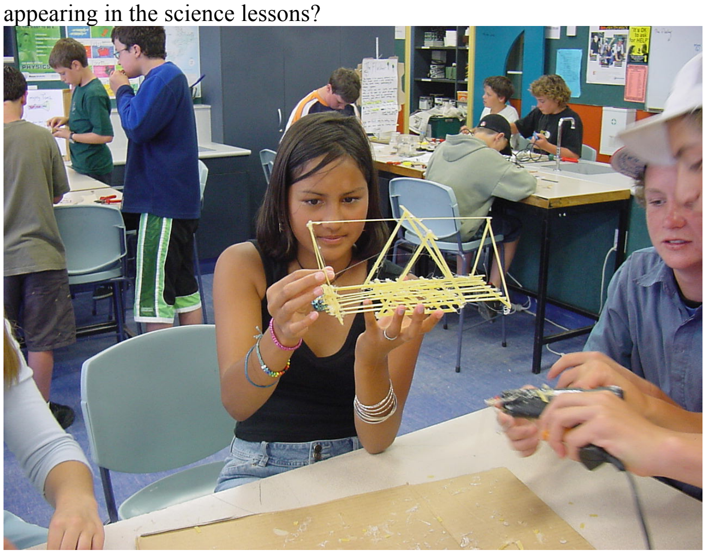


Designing a model of an earthquake proof house.

The lesson designs had tasks that posed opportunities for students to see other ideas, students heard different opinions and there was opportunity to negotiate ideas. On several occasions groups of students used a breakout room to conduct a brainstorm session on multiple whiteboards. Photos were taken of the brainstorms using ipads/chrome books and the students used these to add to their reports. One teacher has described the group discussions: "*It's a shared thinking space where students can grab new ideas, knowing that their peers are hearing their voice and which they can combine their ideas or go with one*". From this combination of increased student autonomy and the opportunity to grapple with fresh ideas two themes emerged.

How do we know a group is genuinely co-operative?

There is nothing special about simply working in a group. So what was observed that was perceived as genuine co-operation appearing in the science lessons?



Making bridges with fettuccini, cardboard and glue-guns

Students were assigned to work together and they sensed there was purpose to their work. They had input into the selection of their group. They knew that their success depended on efforts of all the group members. The roles that they had been assigned were clear and purposeful. They appreciated providing progress updates to the teacher as they advanced through a unit of

work. They worked face to face at a communal table or worked at desks placed close together, if they were working outside of the classroom they were physically close to one another. They showed a commitment to each member of the group and the overall success of the group.

What were the successful co-operative factors?
The teachers were asked to identify and describe in their terms the success factors of student co-operation. What were the important elements of group work in their science lessons and how did they construct them? Four dimensions emerged from the teacher discussions.

Purpose
Hesse et al (2015) reiterate the need for collaborators to generate a shared plan to achieve a "goal state". This suggestion endorses the most talked about factor. The teachers noted the importance of having a purpose or goal for the group to work towards. A task or activity was clearly stated and each member of the group had a specific role to play to respond to the purpose of the task. The task had an inquiry-orientated purpose. Examples of contexts used in the tasks were:

- Investigate to produce hydrogen- carbon dioxide-oxygen gases and test for them.
- Design and build a model bridge to support a 1kg mass-investigate the forces acting.
- Build a model bio-dome to survive a world disaster.
- Make a torch.
- Make a video on the pros and cons of nuclear power in NZ.
- Investigate water rockets and how they work.
- Compare properties of aluminium and iron in weapons.
- Investigate health properties of medicinal native plants.
- Explore an ecosystem of a sand dune- mangrove- forest.

Investigating vinegar and baking soda

Assigning students to groups and group size
The teachers discussed group size, they could see that the smaller the group, the easier it was to identify any difficulties students have in working together, the more difficult it was for students to hide and not contribute their share of work. The larger the group, the fewer the interactions among members, which meant there was less cohesion between them, and more obvious management of roles was needed. However, larger groups invited more discussion and a greater chance of students hearing different opinions. Group size also depended on the activity and resources. If there was a short period of activity then it was better to have smaller sized groups-greater engagement observed. For longer periods of time for example in projects, larger sized groups were seen as successful.
All the teachers used self-selection at the beginning of the year when assigning student to groups, however, as the year proceeded, there were increasingly changes to group members, with both teacher and student input. Teachers discussed the importance of random selection at times through the year, so students had the opportunity to work with different students and the teachers observed positive outcomes from this.

Teaching social skills
Teaching students how to work co-operatively was seen as an important dimension to practice from the teacher perspective. Teachers said there was emphasis on the negotiation of rules for teamwork at the beginning of the year. This emphasis on the importance of roles and what was expected from students was maintained throughout the year. Role-plays were acted out

with students to demonstrate appropriate and inappropriate behaviour. One teacher had written a guide describing steps for encouraging participation in the science lab with social skills for students to actively use.

Assigning roles to ensure interdependence

The teachers saw specific roles as particularly significant (the names of the roles were described in Te Reo Māori in some classes)

The *Director* (Rangatira) was responsible for overall progress and leadership of the team. The director had the responsibility in discussing daily team progress with the teacher and with the class. Some of the directors kept a log of progress- kept notes in a team clear file.

Technician (Kaihangarau)-was responsible for the science equipment, laptop etc getting and returning, handling of apparatus and measurement of data- this was a particularly important role in field research and in active practical science investigations.

Researcher (Kaiwhakamahara)-had the overall responsibility of recording data and information, they ensured all written material was collated and designed for impact to an audience. Data gathered was tabulated and summarised. The researcher developed their skills in collating facts, summarising ideas, used skimming and scanning techniques in reading.

Conclusion

This study confirmed that flexible learning spaces (FLS) in science lessons proved to be a challenging initiative for the teachers. There was no guarantee that co-constructive and cooperative learning would transpire in the new physical spaces, these pedagogical techniques required careful design and implementation. However, a conceptual framework was established, teaching practices identifying successful student co-operation and a documented process of teacher collaborative practice have been recognised. The teachers and researcher have gained valuable knowledge; it has enhanced our understanding of applying new skills meaningfully and creatively in a variety of contexts and situations. This study also signals how changing physical environments such as the flexible learning spaces can influence pedagogical change, an area of science education research that has considerable opportunity for further investigation.

Acknowledgements

The study acknowledges the vital support and contributions of the five secondary schools, the science teachers and students. Acknowledgements also go to academic buddy and fellow researcher Dr Paul Lowe for his active support in earlier studies.

Dr Simon Taylor is Lecturer & Secondary Graduate Programme Co-ordinator, Te Hononga School of Curriculum and Pedagogy, Faculty of Education, University of Waikato, email: simont@waikato.ac.nz

References

Alterator, S., & Deed, C. (2013). Teacher adaptation to open learning spaces. *Issues in Educational Research, 23* (3), 315-330

Hattie, J. A. C. (2005, July). *What is the nature of evidence that makes a difference to learning?* Inaugural professorial address, University of Auckland.

Hattie, J. (2009). *Visible Learning.* New York: Routledge.

Hesse, F., Care, E., Buder, J., Sassenburg, K., & Griffin, P. (2015). A Framework for Teachable Collaborative Problem Solving Skills. In P. Griffin & E. Care (Eds.), *Assessment and Teaching 21st Century Skills: Methods and Approach* (pp.37-56). Dordrecht: Springer.

Lowe, P. (2004). PhD Thesis. The Effect of Cooperative Group Work and Assessment on the Attitudes of Students towards Science in New Zealand: http://link.library.curtin.edu.au/p?cur_digitool_dc15358

Ministry of Education. (2016). *Flexible learning spaces webpage.* Retrieved from http://www.education.govt.nz/school/property/state-schools/design-standards/flexible-learning-spaces/

Nuthall, G. (2007). *The Hidden lives of learners*. Wellington: NZCER Press

Roseth, C. J., Fang, F., Johnson, D. W., & Johnson, R. T. (2006, April). *Effects of cooperative learning on middle school students: A meta-analysis*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Taylor, S. (2014). The Seedling*: Students' perceptions of science education*. New Zealand Science Teacher. Edition 133. Teacher print journal.